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Retraction in Orthodontics – A Short Review

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Abstract

Aim- The aim of this review is to discuss about the retraction mechanism in orthodontics and to discuss in detail regarding the mechanism of action and their application in orthodontics.

Objective- To list out the difference types of retraction mechanics used and their merits and demerits

Background- The basic principle of retraction mechanism can be used in orthodontic space closure involving retracing the canine initially followed by remaining anterior teeth or entire anterior teeth can be retracted at once using intra or extra oral anchorage. They are broadly classified into friction and frictionless mechanism. Once the extraction of the teeth has been done, the orthodontist must choose the procedure to retract the teeth based on the demand of the case. This article provides the basic information of both the mechanics and their application in orthodontics.

Reason- This review mainly done for better assessment and benefits of retraction mechanics and its appliances

Keywords- *Two step retraction, loop mechanics, enmass retraction, space closure*

Introduction

The different methods to close spaces, reduce procumbency, overjet, and eliminate extraction sites by antero-posterior therapy is generally categorized as Retraction mechanics. Whether retracting the anterior or protracting the posterior or a combination of both principles of retraction mechanics apply for space closure remains the same [1]

As extraction was done in late 19th century finger springs or other methods were employed for simple pushing back of canine teeth. This often resulted in tipping and elongation of teeth. Tweed used the molars as anchorage by tying back the arch and using a coil spring arch to retract the cuspids back with the help of 0.016 round archwire. In 1980, rickets employed closed coil springs to obtain sectional cuspid retraction. Several studies have been made on the amount of force required for specific tooth movements. Storey and Smith' reported that 150 to 200 grams is the optimum force range for retraction of the lower canine tooth. Reitan' has reported that the maximum force needed for continuous bodily movement of canine teeth is 250 grams. Burstone and Groves found the optimum force for the retraction of anterior teeth to be 50 to 75 grams. Lee in 1966 showed optimal force for distal movement of maxillary canine with tipping was 15 to 260 cm. Burstone in 1982 developed composite TMA spring for canine retraction [2]. Poul gjessing in 1985 developed a sectional arch technique that produces optimal force system for controlled canine retraction.

Determining the anchorage value while retracting the teeth is of major concern no matter the technique used.

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Maximum anchorage is indicated when only anterior teeth are retracted. Minimum anchorage is used if only posterior teeth is protracted and when combination of both is used moderate anchorage is used.

Retraction is the most frequently used technique in space closure. The strategy used in retraction mechanics must be based on a careful diagnosis and treatment plan made according to the specific needs of the individual. Two step retraction and en mass retraction are two most used mechanics in anterior retraction. In two step retraction retraction of canine teeth is done followed by retraction of all four incisors and en mass retraction involves retraction of all six teeth [3]. Two step retraction involves retraction of canine teeth in one step later retracting followed by retracting the remaining teeth in next step. This will reduce the tendency of anchorage loss by incorporating more teeth in the anchorage unit. However, this will take longer time to complete the treatment. In addition when the entire anterior unit is retracted compared to canine retraction they tend to tip and rotate less, thus requiring less time and effort when compared to canine retraction. En mass retraction occurs when incisors and canines are retracted together. In clinical situation it is difficult to maintain anchorage in clinical situation. Anchorage can be derived from segment of the teeth or the entire arch. In some difficult situations the requirement for extra oral anchorage such as headgear, face mask, intermaxillary elastics and mini implants is needed.

The principles for retraction currently used can be explained as either frictional system in which teeth is allowed to slide distally and it's guided by continuous arch wire or a non-frictional system with couples and force built into the loops of an arch section [4].

Mechanics of Tooth Movement

Every free body or an object can be perfectly balanced on one point which is known as centre of gravity. The relationship between line of action of force to the center of the body determines the movement of the free body. In a tooth which is a restrained body, a point similar to the centre of gravity is used which is known as centre of resistance.

If the force passes through the center of resistance an object undergoes translation. The centre of resistance is on the long axis of the tooth for single rooted tooth and probably between one third and one half of the root length apical to alveolar crest for a multirooted teeth.

A body appears to rotate around its center of rotation. The more translational the moment of the tooth the farther apically the centre of rotation would be placed. Moment is defined as tendency to rotate [5]. If the line of action of force does not pass through centre of resistance it will produce some rotation which can be calculated as force multiplied by perpendicular distance from centre of resistance to point of application of force. When two forces of equal magnitude act in opposite direction it will produce a couple. This will produce pure rotation, spinning the object around its centre of resistance. The way an object is rotates while its being moved can be changed by different combination of force and couple.

The ratio between magnitude of couple and the amount of force applied at the bracket determines the type of tooth movement exhibited by the tooth. A single force produces a uncontrolled tipping so in order to produce a controlled tipping or translation a single force is insufficient, a rotational tendency (moment) must also be applied at the bracket.

A force of 100 grams produced at a distance of 10mm from the centre of resistance produces a clockwise moment of 1000gm-mm which will cause tipping of the tooth. we must generate counter balancing moment of 1000 grams-mm so that bodily moment can be achieved since the tipping is undesirable. This can be done by twisting the anterior segment of rectangular wire and fitting it into a rectangular slot. After the wire is engaged in a bracket slot it generates an inherent moment of couple which is a couple produced within the wire itself and now it will result in bodily movement of the teeth [6].

RETRACTION MECHANICS IN EDGEWISE

Once the extraction of the teeth is done orthodontist have to plan how to close the space. There are two schools of thoughts of retraction mechanism:

i. Two step canine retraction [Friction or frictionless mechanics)

ii. En-mass retraction [Friction or frictionless mechanics)

FRICTION MECHANICS

A tooth can be moved bodily only when force is applied such that it can pass through center of resistance. When a bracket is placed on a tooth and the force is applied at it, both force and moment is experienced by the tooth. The tooth moves in two planes due to this moment of force. The canine moves mesial out as force is applied buccal to center of resistance due to one moment. The second moment produces distal tipping of tooth is caused because force is applied occlusal to centre of resistance. A moment in opposite direction is produced due to interaction between the bracket and wire which counteracts this moment. When the tooth tips in distally it glides along the archwire till binding occur between the archwire and the bracket. This produces a couple at the bracket which results in distal root moment and hence uprighting of the tooth. As it uprights the moment decreases until the wire can no longer bind [7]. Then the canine retracts along the archwire till distal crown tipping again causes binding. Until the force gets depleted this continuous to take place which is known as walking of canine because of initial tipping of crown followed by root uprighting. The major advantage of friction mechanism is it provides comfort to the patients and less time consuming as complicated wire bending is not required.

V – BEND SLIDING MECHANICS

This was developed by Thomas F Mulligan, this approach is used for closing space by moving each teeth (canine retraction or molar protraction). He gave the concept of differential torque as a means of effective intraoral anchorage. It is obtained by applying unequal alpha and beta moments. An off center V- bend is used in a wire to create unequal moments with higher moment applied to the anchorage teeth. The closer the bend is to the bracket shorter the wire and shorter wire has a higher bending moment than a longer wire. Therefore, a higher moment acts on the bracket which is closer to the V bend than the more distant bracket [8].

In case of canine retraction using the V-bent mechanics the tooth located closure to the bend is the anchor side and the opposite is the non-anchor side. As the cuspids continue to move distally, the bend is centered and the differential torque begins to gradually disappear. Root parallelism begins to effect as the bend approaches the center.

METODS OF CANINE RETRACTION IN SLIDING MECHANICS:

1. Elastic module with ligature
2. Elastomeric chain or power chain
3. Intra or inter maxillary elastics to kobayashi ligature
4. Coil springs (stainless steel or NiTi)
5. J-hook head gear
6. Sliding jig and traction
7. Mulligans v bend sliding mechanics

ELASTIC MODULE WITH LIGATURE

This method of retraction has been popularised by Bennett and McLaughlin (Fig A). A single elastic module is used to secure the arch wires to brackets which is attached to canine by a ligature wire extending from the molar. These elastic tie backs are activated 2-3 mm or to twice then original size to generate approximately 100 – 150 grams [9].

Figure A: Elastic modules

ELASTOMERIC CHAIN OR POWER CHAIN

E chain were introduced into the dental profession in 1960 for canine retraction, diastema closure, rotation correction and arch constriction. (Fig B) They are available in configuration of closed loop, short filament, and long filament chains. It has many advantages such as being inexpensive, relatively hygienic and can be easily applied without arch wire removal and do not depend on patient cooperation. Most of elastomeric chains lose 50% - 70% of their initial force during the 1st day of force application and at three weeks retain only 30% -

40% of their original force. Elastomeric chains should be changed every 4 – 6 weeks [10].

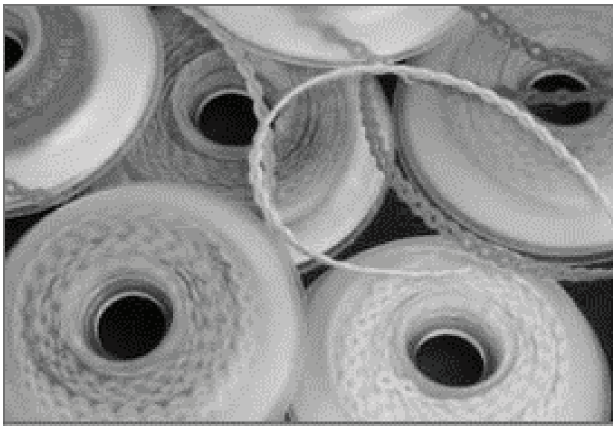

Figure B: Elastomeric chain

COIL SPRINGS

Coil springs were introduced in the year 1931. The various materials that have been used in making springs are stainless steel and NiTi. Stainless steel are more efficient because they apply more predictable level of force compared to elastic based system. However stainless-steel springs have relatively higher load deflection rate so as space starts to close there is some force degradation due to lessening activation. Nickel titanium coil springs were introduced by Samuels and Rudge in 1979 (Fig C). They are indicated if large spaces need to be closed. The force degradation is very less due to low load deflection rate. They are available in lengths of 9mm and 11mm. The advantage of springs is that they can easily be placed and removed without removal of arch so patient cooperation not much needed but it is relatively unhygienic compared to elastic system.

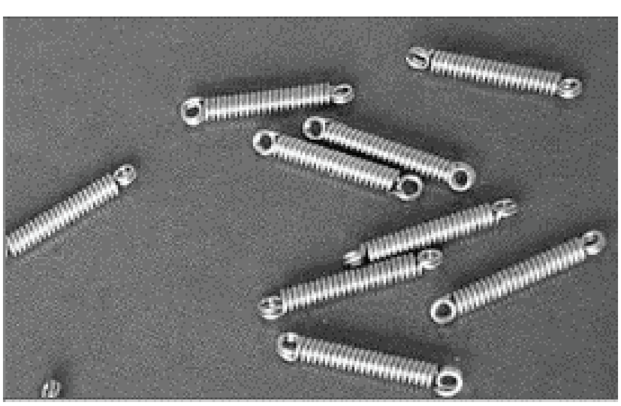

Figure (Fig C): Nickel titanium coil spring

J-HOOK HEADGEAR

It can be used for distal movement of canines without causing loss of posterior anchorage. It involves the use of headgear with j hooks where the hooks attach along a continuous arch wire mesial to the canines and exert a force over them so that they will slide along the arch wire. Since it incorporated extra oral anchorage in canine retraction, it should be effective in maximum anchorage cases [11].

SLIDING JIG AND TRACTION

0.022 round wire or 0.017 x 0.022 rectangular wires are used in making this jig and it is slide on to the arch wire in addition to a short piece of open coil spring of about 4mm in length. The coil spring lies in contact with mesial end of canine bracket and circle of jig lies on mesial end of coil spring. The traction can be applied to the jig either intra or inter maxillary elastics or by extra oral traction.

MULLIGANS V BEND SLIDING MECHANICS

It was introduced by mulligan 1970's. The basic principle was to apply differential moments to the teeth via bends in the continuous arch wire while force for retraction was applied by auxiliaries like E chain, coil springs etc. during cupid retraction [12]. The 45 degrees v bend are added to the wire and 200 grams of force are applied without removing the archwire using calibrated optic pliers.

The v bend helps in differential medio distal movements on the canines and molars. If the bend is placed off center it creates a short and a long segment. The shorter segment is more rigid and hence applies greater moments. So, if maximal canine retraction is required the bend is placed very close to molar and bicuspid. This causes a strong distal crown moment on the molar which counteracts the auxiliary force tending to move the molar crown forward.

EN-MASS RETRACTION

It literally means retracting group of teeth together as a single unit. The anterior teeth are intruded and retracted simultaneously and also maintaining the torque control however, demand on the anchorage should be evaluated carefully [13]. It can be effectively employed in moderate and minimum anchorage cases. In frictionless mechanics retraction is done with a continuous wire with one closing loop each side distal to cupid. Various loop design are available for retraction and all are having pre-determined vertical heights ranging from 7-10 mm in vertical direction to keep it closer to centre of resistance of tooth.

In 1990s, a method of controlled space closure was described using sliding mechanics. Rectangular archwire 0.019 x 0.025 wires are recommended with the 0.022 slot. This wire size had good overbite control while allowing free sliding through the buccal segment [14]. Thicker wires sometimes restrict free sliding of molars and premolars and thinner wires have less control. Thinner wires along with the heavy forces of E- chain can give rise to roller coaster kind of effect.

Soldered hooks of 0.7 brass hooks can be used and alternatively soft stainless steel (SS) 0.6 soldered hooks can also be used. The most common hook length are 36 – 38 mm in upper and 26 mm in the lower arch.

Active tiebacks refer to use of stainless-steel ligatures threaded through an elastic module that goes directly from the terminal molar to the canine bracket. They are stretched to their original size during activation, without pre stretching the force levels range between 200-300 grams. If large spaces are to be closed Niti coil spring are used instead of elastomeric module. The force decay in the Niti coil spring is very much less as compared to elastomeric modules.

FRICTION ISSUE IN SLIDING MECHNICS

Using the friction mechanism has few disadvantages during retraction because of mainly two components friction and binding, due to which applied force should be higher than the required optimum force because of decay in force. When E chain is used for retraction if excessively stretched leads to breakdown of internal bond leading to permanent deformation. It also absorbs water and saliva when exposed to oral environment causing degradation of force by 50%-70% by 1st day. Due to these drawbacks in friction or sliding mechanism, frictionless mechanism is in better position for retraction, as monitoring of optimum force can be done effectively, and it is active for longer duration of time [15].

FRICTIONLESS MECHANICS

In frictionless mechanism retraction is accompanied with loops or springs which offer more controlled tooth movement than sliding mechanism. In frictionless mechanism when the loops are activated, they distort from their original shape as the tooth moves and then it gradually returns to its undistorted (preactivated) position, delivering the energy stored at the time of activation. It is activated by by pulling the arms of the loop away and cinching them back at the molar tubes. Thus, this approach is friction free, so can be used to move group of teeth more accurately with more precise anchorage control to achieve treatment goals more readily than methods in which friction plays a role [16].

The Gable bend and Neutral Position

A simple loop when activated is unable to generate adequate counter moment required to achieve the desired tooth movement so preactivation bends also known as gable bends are given which increases the M/F ratio. To maintain the neutral position of the loop which has been altered by the introduction of gable bends, appropriate magnitude and occlusogingival location of the gable bends are vital. Because of the gable bends, the closing loop functions as V- bend in the arch wire. Practically, this means that during canine retraction with the vertical loop placed closed to a canine, a higher ratio M/F ratio would be present on the canine which could better control the apex. The undesirable effect is extrusion of the canine.

Preactivation bends or gable bends can be placed within the archwire or where loop meets the archwire which are placed to increase M/F ratio. For anterior retraction loops should be placed closer to the canine than to the molar and a gable bend should be added near the molar. A gable bend that is larger in the posterior dimension will produce a larger beta moment thus increasing posterior anchorage. For both retraction of anterior and protraction of anterior segment the loop should be placed midway between posterior and anterior segments. A gable bend of equal dimension should be used so that alpha and beta moments are equal and reciprocal space closure occurs [17]. When only posterior protraction is desired, the loop should be located closer to the posterior segment and anterior gable bend should be placed with a greater alpha moment than beta moment, making the anterior teeth the anchorage segment.

METHODS OF CANINE RETRACTION IN

FRICTIONLESS MECHANICS

1. Ricketts retraction spring
2. Poul gjessing spring
3. Burstone T loop retraction and attraction spring
4. Marcotte spring
5. Drum spring
6. Opus loop
7. Kalkra simultaneous intrusion retraction spring
8. Wave spring
9. A statistically determined retraction system
10. Niti canine retraction spring

RICKETTS RETRACTION SPRING

Maxillary cuspid retractor is a combination of a double vertical closed helix and an extended crossed T closing loops spring which contains 70mm of wire. (Fig D) It produces 50 grams per mm of activation. The additional wire in its design helps in activation of the spring by contracting the loops and 3 – 4 mm of activation for upper cuspid is sufficient for retraction. Mandibular cuspid spring is a compound spring with a double vertical helical closing loop. It contains 60 mm of wire and produces approximately 75 grams of force per mm of activation [18]. Activation of 2 – 3 mm is required to produce the desired force.

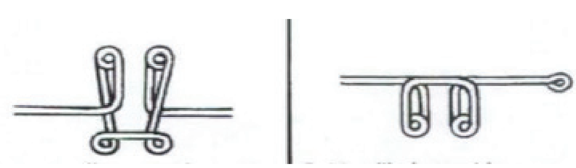

Figure D: Ricketts retraction spring

POUL GJESSING SPRING

The Poul Gjessing maxillary canine retraction spring was described by Poul Gjessing in 1985. Essentially the spring consist of a double ovoid helix with a smaller occlusally places helix and is in the preformed version is available commercially constructed in 0.016 x0.022 inch stainless steel wire. The spring is activated by pulling distal to molar tube until the two loops separate (Fig E). The amount of activation produces the recommended initial load of 100 grams. It is critical to avoid over activation of the spring because a few mm of over activation can result in anchor loss. Since the average distance from the centres of the brackets to the CR are identical for the upper and lower canines, the PG retraction spring works equally well for canine retraction in either arch.

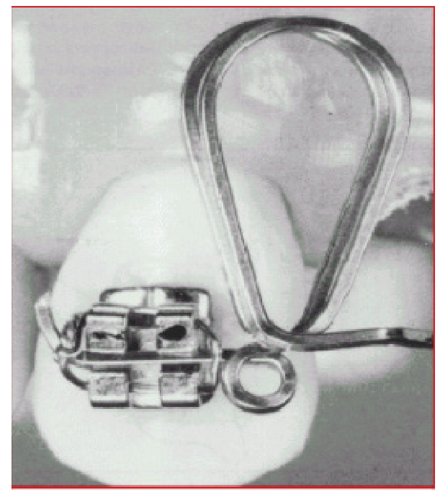

Figure E: Poul gjessing spring

BURSTONE T LOOP RETRACTION AND ATTRACTION SPRING

The burstone composite 'T' loop retraction spring is made from 0.017 x 0,025-inch TMA wire. T loop retraction spring can be used in group A arches. The attraction springs are used in group B and group C arches. The difference lies in rotational control of the canine, which is achieved with a non-sliding mechanism. Antirotational bends are placed in the retraction assemblies to prevent the canine from rotation as it retracts. It is also possible to use an arch wire to prevent rotation. It is engaged into auxiliary tube of first molar and the vertical tube on the burstone canine bracket. Initially after preactivation controlled tipping occurs (M/F 8:1), as space closes and spring deactivates, the force level decreases so translation occurs (10:1), further deactivation leads to root movements (12:1) [19].

MARCOTTE SPRING

This is a type of minor cuspid retraction spring and is small, light 0.016 closing loop. This spring extends from the auxiliary tube of 1st molar brackets to the bracket on the cuspid and it is activated by being pulled through the auxiliary tube and cinched. The buccal segment feels, then a protractive force and a positive moment, while the tooth being "walked back" on the wire. Hence are used in group B and group C arches. Activation should be limited to 1-2 mm.

OPUS LOOP

This new design can be fabricated from 16 x 22 or 18 x 25 or 17 x 25 TMA wire. The loop is positioned off center about 1.5mm from the mesial canine bracket. It is activated by tightening it distally behind the molar tube and can be adjusted to produce maximum, moderate, or minimum incisor retraction. It also delivers a nonvarying target M/F within the range of 8.0 – 9.1 mm inherently, without adding residual moments by twist or bends anywhere in the archwire or the loop [14].

KALRA SIMULTANEOUS INTRUSION RETRACTION SPRING (K – SIR)

It is made up of continuous 019 x 025 TMA arch wire with closed 7 mm x 2mm U – loops at the extraction site for en masse retraction. The u loop has a 90 degree bend to create equal and opposite moments. A 60 degree V – bend is also located posterior to the center of interbracket distance producing n increased clockwise moment on the first molar [16].

A STATICALLY DETERMINATE RETRACTION SYSTEM

This novel system consisted of a single – force cantilever arm of 017 x 025 TMA for active retraction and a passive rigid stabilizing unit. A turn of helix is placed in front of auxiliary tube for the molar and ended with a hook on its anterior end. A 90 bend is placed in middle of spring. The spring is activated 90 at the helix as well [17].

THE WAVE SPRING

This spring can be used where a closed coil would be appropriate for retraction. It is made up of superplastic nickel titanium alloy delivering large amount of activation about 90g of force from extremely a compact spring only 6mm long in its resting state [18].

NITI CANINE RETRACTION SPRING

The spring is available in 016 x 022 NiTi wire with antitip and antirotational incorporated. It has an ability to deliver continuous force and moments over a broad range on activation [5].

RAPID CANINE RETRACTION THROUGH DISTRACTION OF PERIODONTAL LIGAMENT

Liou and huang in 1998 proposed a concept in which first premolar of the patient is extracted then the interseptal bone distal to canine is undermined by a bone bur. After debridement of that area tooth born custom made distraction device is placed which helps in retraction of canine within three weeks into the extraction space. No complications were also observed during or after the treatment [20].

CANINE RETRACTION WITH RARE EARTH MAGNETS

In a study conducted by john daskalogiannaskisa and Kenneth roy in 1996 they hypothesised that a prolonged constant force provides more effective tooth movement than a impulsive force of a short duration arylene coated neodymium-iron-boron block magnets were used in the experiment. The appliance provided a constant force, and this method was two times faster than the conventional methods of retraction as they use interruptive force which degrade after some time [21].

CANINE RETRACTION WITH REMOVABLE APPLIANCES

Canine retractors are the springs which are used to move the canine in distal direction.

THE VARIOUS TYPES OF CANINE RETRACTORS ARE AS FOLLOWS:

Palatal Canine Retractor: The distal movement of the canine teeth can be brought about by a palatal canine retractor if the canine is palatably placed which is made out of 0.6mm stainless steel wire with a coil of 3mm diameter, an active arm and a guide arm. The helix is placed along the long axis of the canine. Activation is done by opening the helix 2mm at a time.

The 'U' Loop Canine Retractor: Mechanically it is least effective and used when only minimum retraction of 1-2mm is required. It is made of 0.6mm stainless steel wire. It consists of a U loop, an active arm and a retentive arm which is distal. The base of the U loop is 3mm below the cervical margin. It is activated by closing the U loop. The advantages of this retractor are its simplicity of fabrication and lesser bulk [22].

Reverse Loop Buccal or Helical Canine Retractor: It is used when the sulcus is shallow, as in the lower arch. Its flexibility depends on the height of the vertical loop and should be as high as possible. It is made of 0.7mm stainless steel wire. Activation is done by cutting off 1mm of wire from the free end and re-forming it to engage the mesial surface of canine.

Buccal Canine Retractor: The buccal canine retractor is used when the tooth must be moved palatally and distally. It is made of 0.7mm stainless steel wire to provide sufficient strength. It should not be activated by more than 1mm because it is stiff and force decays rapidly as the tooth moves which results in difficulty to maintain continuous tooth movement [12].

Supported Buccal Retractor: It is made of 0.5mm stainless steel wire supported in a tubing of 0.5mm internal diameter. It is more than twice as flexible as the standard canine retractor, the tubing imparts excellent stability.

RETRACTION IN BEGGS TECHNIQUE

The begg technique advocates a two-stage retraction. The first stage involves distal tipping of the anterior crowns with elastomerics and/or interarch elastics. Begg brackets permit only a point contact between bracket and archwire, so no moment is produces by wire bracket interaction. As a result, uncontrolled tipping of the anterior teeth occurs during the first stage of retraction. The second stage involve lingual torqueing of the anterior roots, usually by means of torqueing auxiliary. A moment to force ratio of about 12:1 is required, and such a high ratio is technically difficult to achieve. For this reason, two-stage retraction with initial uncontrolled tipping is not the most efficient retraction method [23].

Conclusion

Depending upon the condition and severity of malocclusion and treatment techniques employed, a number of methods are used for the retraction of canine either by fixed or removable orthodontic appliances. Every situation requires different technique because of its own limitations. Thus the individual clinician must choose the method he prefers to treat malocclusion which requires tipping or bodily movement or rotation of teeth with minimal time, to produce an aesthetic and functional and near ideal occlusion as much as possible.

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